Appendix A. Recommended Field Test Outline – FM-band

IBOC FIELD TEST GUIDELINES – FM

February 9, 1999

Test Objectives

1. Assess system performance with low multipath, low interference, and weak to strong signal.
2. Assess performance with strong multipath, low interference, and strong signal.
3. Spot-check home receiver compatibility (PLL stereo decoder) in strong signal areas at **fixed sites** on station that is broadcasting **classical music** with **conservative** processing.
4. Spot-check 67 kHz and 92 kHz analog subcarrier performance at same strong signal sites tested for home receiver compatibility.
5. Assess system performance with a single 1st adjacent interferer and moderate to strong multipath.
6. Assess IBOC performance with two first adjacent analog interferers.
7. Evaluate IBOC digital performance with two-second adjacent (IBOC) interferers at or near FCC maximum allowed interference level.
8. Assess digital and analog impairments.

IBOC FIELD TEST GUIDELINES – FM BAND REVISION #3a February 9, 1999					
Test Group	Test & Frequency	TEST PROCEDURE	Type of Evaluation	Signal Conditions	Test Results
A Calibration	1. Power (at the start and end of test period or as needed)	1. IBOC analog and digital power will be read separately at the output of the combiner (total average digital). 2. The digital average and peak power will be measured at the output of the digital exciter and through the digital amplifier. 3. A common analog/digital-transmitting antenna is strongly recommended. If separate antennas are used comprehensive field analog to digital power ratio measurements are recommended. 4. With separate transmitting antennas the analog to digital power ratio will vary in the field. Because this will have an effect on analog compatibility, step B.3 should be expanded to at least 50 test sites based on a grid.	Objective	NA	Analog/digital power levels Peak to average power ratios at exciter and HPA outputs
	2. Spectrum (daily)	1. Spectrum analyzer plots of the system RF spectrum will be taken at the output of the combiner. 2. The spectrum analyzer settings will be: RES BW 1 kHz, and sweep span 2 MHz (transmission line test).	Objective	RF signal level at least –45 dBm	Daily power ratios and out-of-channel radiation measured at output of combiner
	3. Weak signal (weekly)	1. TOA should be found at the output of the digital transmitter using a weak signal or noise added test. The test should be performed using an attenuator with at least 1 dB per step. 2. Impairment or program audio may be used.	EO&C	Signal level variable	Daily check on system performance
	4. Proof (beg. and end of test period)	An analog transmission system test should be conducted using a high quality FM demodulator.	Objective	FM transmitter output	Record of frequency response, separation, and distortion for the test record
	5. Monitor calibration	The analog FM modulation monitors should be calibrated using Bessel nulls. If Bessel nulls are not used, a description of the test procedure should be included in the proponent report.	Objective	FM transmitter output	Calibration results recorded in record
	6. Transmitting antenna performance and data	Antenna data to be supplied with report: 1. Transmitting antenna specifications. 2. The results of a recent antenna sweep. 3. Antenna installation description (PA to antenna).	Objective	NA	Record of transmitting antenna performance.
	7. Receiving antenna performance and data	1. Each proponent should supply a detailed description of the receiving antenna and RF distribution system. 2. Receiving antenna should be tested on a certified test range. 3. If any active RF device is used, a full set of RF performance tests results should be supplied with the report.	Objective	NA	Antenna plots and data
	8. Data to be reported	1. Continuous 500 kHz (span) spectrum plots recordings. 2. Visual recording depicting the test environment. 3. Digital recording of IBOC audio. 4. Digital recording of analog signal. The in motion receivers should be automotive type, one with aggressive blend and the second with conservative blend (see figure). The home type fixed receivers should use conventional PLL stereo decoder. 5. Error rate performance metric recorded during test run.	Objective EO&C	NA	Needed for full analysis and interpretation of results
	9. Interference	1. The specified interference levels (D/U) will be calculated. 2. The interference levels should be **measured** along the test route.	Objective	As specified in test	Calculated and measured D/U ratios vs. location

IBOC FIELD TEST GUIDELINES – FM BAND REVISION #3a February 9, 1999					
Test Group	Test	TEST PROCEDURE Objectives: • System performance without interference • System performance with multipath and no other interference • "Stoplight" fade performance • Host analog compatibility • Subcarrier compatibility Note: 1. Mobile tests to be conducted at speed limit or with traffic flow. 2. Digital recordings will be made of all compatibility receiver tests.	Type of Evaluation	Signal Conditions	Test Results
B Strong signal with low interference	1. Low multipath	1. This test should be conducted in an FM station's coverage area where the 1st adjacent analog signal is at least 10 dB below the digital signal. With a host analog to digital power ratio of 22 dB, the analog D/U would be 35 dB. 2. The undesired analog second adjacent D/U should not exceed a D/U of –20 dB in the test area. 3. Digital program material may be the same as analog. Program material should include segments that will not mask digital impairments. 4. If impairments are not heard, the above runs should be repeated with the signal attenuated until impairments are heard.	EO&C audio impairments in field or by digital recording. Digital error rate performance metric	Weak to strong signal area with low interference. (not to exceed 69 dBu)	System performance with minimum interference Digital error rate performance metric for run Step B.1.4 is unnecessary if the error rate performance metric is included
	2. Strong multipath	1. Test in strong areas where the interference is no worse than in B.1.1 and B.1.2. The test environment should include some terrain-obstructed routes with strong delay between 13 and 18 microseconds. 2. Additional tests in multipath areas at very slow speeds (less than 1 mph with frequent stops). 3. Digital program material may be the same as analog. Program material should include segments that will not mask digital impairments. 4. If impairments are not heard, the above runs should be repeated with the signal attenuated until impairments are heard.	EO&C audio impairments in field or by digital recording Digital error rate performance metric	Moderate signal area with low interference (not to exceed 66 dBu)	System performance with multipath Digital error rate performance metric for run Step B.2.4 is unnecessary if the error rate performance metric is included
	3. Host Compatibility	1. Fixed compatibility tests should be conducted using receivers with conventional PLL (switching) stereo decoders. 2. The digital signal should be switched on and off at a rate that will allow the observers to rate possible interference. 3. Compatibility tests should be conducted using an IBOC analog station broadcasting classical music with conservative analog processing. 4. Digital recordings should be made of the analog audio for further subjective evaluation.	Subjective	Strong signal area (at least 70 dBu)	Subject rating of interference using the five step CCIR impairment scale
	4 Subcarrier	1. At the above compatibility test sites the 67 kHz and 92 kHz analog subcarrier audio S/N should be measured with the digital signal switched on and off. (67 kHz filter data to follow) 2. With normal station audio modulation (including subcarriers) and using a wideband receiver, plot the baseband noise from 1 kHz to 100 kHz with the IBOC signal on and off.	Objective	Strong signal area (at least 70 dBu)	Subcarrier S/N with and without the digital signal Plots of any variation in noise floor with the IBOC signal

IBOC FIELD TEST GUIDELINES – FM BAND REVISION #3a February 9, 1999					
Test Group	Test	Test Procedure Objective: System performance with first adjacent interference Notes: 1. Test route desired and undesired signal levels should be reviewed (measured) prior to test runs and compared to predicted values. 2. Test to be conducted at speed limit or with traffic flow.	Type of Evaluation	Signal Conditions	Test Results
C Single interferer	1. Single first adjacent analog calculated near FCC (6dB D/U) With moderate to strong MP	1. Test runs should be in areas where the calculated 1st adjacent interference averages 6 dB below the desired. The desired signal level should average close to the signal level expected at the protected contour. 2. Any other first adjacent interference should be at least 25 dB below desired signal and analog 2nd adjacent no higher than 20 dB above the desired FM. 3. Digital program material may be the same as analog. Program material should include segments that will not mask digital impairments.	EO&C audio impairments in field or by digital recording Digital error rate performance metric	Signal level average 60 dBu	System performance with first adjacent interferers Record any impairments or changes in audio quality Digital error rate performance metric for run
	2. Strong first adjacent	Test C.1 should be repeated in areas where the interference averages 12 dB higher than the desired composite signal (D/U –12 dB).	EO&C audio impairments in field or by digital recording Digital error rate performance metric	Signal level average 60 dBu	System performance with single channel Record any impairments or changes in audio quality Digital error rate performance metric for run

IBOC FIELD TEST GUIDELINES – FM BAND REVISION #3a February 9, 1999					
Test Group	Test	Test Procedure Objectives: • System performance with two adjacent channel interferers • System performance with varying levels of interference Notes: 1. Test route desired and undesired signal levels should be reviewed (measured) prior to test runs and compared to predicted values. 2. Tests to be conducted at speed limit or with traffic flow.	Type of Evaluation	Signal Conditions	Test Results
D Two interferers	1. Two 1st adjacent analog interferers Moderate MP	1. Test runs should be in areas where the calculated 1st adjacent interference averages 6 dB below the desired. The desired signal level should average close to the signal level expected at the protected contour. One analog interferer should be an existing station, and the second may be a low power station operating with a temporary authorization. 2. The test vehicle should make at least one run that starts with a low interference area and extends to the test area described in step D.1.1. 3. Digital program material may be the same as analog. Program material should include segments that will not mask digital impairments.	EO&C audio impairments in field or by digital recording Digital error rate performance metric	Signal level average 60 dBu D.1.2 signal varying	System performance with two 1st adjacent interferers Digital error rate performance metric for run
	2. Two 2nd adjacent IBOC interferers Moderate MP	1. Test runs should be in areas where the calculated 2nd adjacent composite IBOC interference average is at least 20 to 40 dB above the desired . 2. The test vehicle should make at least one run that starts with a low interference area and extends to the test area used in step D.2.1. 3. Digital program material may be the same as analog. Program material should include segments that will not mask digital impairments.	EO&C audio impairments in field or by digital recording Digital error rate performance metric	Signal level average 60 dBu D.2.2 signal varying	System performance with two 2nd adjacent interferers Digital error rate performance metric for run

Appendix B. Recommended Field Test Outline – AM-band

IBOC FIELD TEST GUIDELINES – AM

February 17, 1999

Test Objectives

1. Assess system performance with low interference and strong to weak signal levels.
2. Assess performance with fading and low interference.
3. Spot-check analog receiver compatibility.
4. Assess system performance with daytime interference.
5. Assess system performance with station nighttime operation within the protected contour.
6. Assess sky-wave performance.
7. Assess digital/analog audio impairments.
8. At least one directional station should be used for the tests.

IBOC FIELD TEST GUIDELINES – AM BAND REVISION #2a February 17, 1999					
Test Group	Test & Frequency	TEST PROCEDURE	Type of Evaluation	Signal Conditions	Test Results
A Calibration	1. Power (at the start and end of test period or as needed)	1. Where possible IBOC analog and digital power will be read separately at the output of the transmitter. 2. If this is not practical, the power ratios will be measured with a spectrum analyzer.	Objective	NA	Analog/digital (all) power levels Peak to average power ratios
	2. Spectrum (daily)	1. Spectrum analyzer plots of the system RF spectrum will be taken at the output of the combiner. 2. The spectrum analyzer will be set up in accordance with FCC 73.44, with sufficient span to include 3rd order intermodulation products.	Objective	RF signal level at least 2 mV	Daily power ratios and out- of-channel radiation measured at output of combiner
	3. Weak signal (weekly)	1. TOA should be found at the output of the digital transmitter using a weak signal or noise added test. The test should be performed using an attenuator with at least 1 dB per step. 2. Impairment or program audio may be used.	EO&C	Signal level variable	Daily check on system performance
	4. Proof (beginning and end of test period)	1. An analog transmission system test should be conducted using a high quality AM demodulator. 2. Host AM transmitter should use NRSC pre-emphasis.	Objective	AM transmitter output	Record of frequency response and distortion
	5. Monitor calibration	Monitor manufactures recommended procedure or certified lab.	Objective	AM transmitter output	Calibration results recorded in record
	6. Transmitting antenna performance and data	Antenna data to be supplied with report: 1. Transmitting antenna specifications. 2. The results of a recent proof. 3. Day and night detailed characteristics.	Objective	NA	Record of transmitting antenna performance for day and night operations
	7. Receiving antenna performance and data	1. Each proponent will supply a detailed description of the receiving antenna and RF distribution system to compatibility receivers and test equipment. 2. If any active RF device is used, a full set of RF performance tests will be supplied with the report.	Objective	NA	Antenna plots and data
	8. Data reporting	1. Continuous spectrum plots video recorded (at least 50 kHz span), to include total spectrum of 2nd adjacent channels. 2. Visual recording depicting the test environment. 3. Digital recording of IBOC audio. 4. Digital recording of analog signal. Two in motion receivers to be automotive type (narrow band and NRSC). 5. Error rate performance metric recorded during test run.	Objective EO&C	NA	Needed for full analysis and interpretation of results
	9. Interference	1. The specified interference levels (D/U) will be calculated. 2. The interference levels should then be **measured** along the test route. 3. Characterize AM band RF propagation conditions. 4. Record weather conditions at time of test (temp, rain, fog, snow, etc).	Objective	As specified in test	Calculated and measured D/U ratios vs. location Propagation, weather conditions

IBOC FIELD TEST GUIDELINES – AM BAND REVISION #2a February 17, 1999					
Test Group	Test	TEST PROCEDURE Objectives: • System performance without interference • System performance with fading and low AM station interference • Host analog compatibility Note: 1. Mobile tests to be conducted at speed limit or with traffic flow. 2. Tests should be repeated for all proposed transmission bit rates. 3. Digital recordings will be made of the digital and analog compatibility receivers' audio for all test runs.	Type of Evaluation	Signal Conditions	Test Results
B System performance within protected contour and low interference (day)	1. Low fading	1. These tests should be conducted in the test station's coverage area where the 1st adjacent interference is at least 20 dB below the desired analog, and co-channel analog interference is at least 30 dB below desired analog. 2. Digital program material may be the same as analog. Program material should include segments that will not mask digital impairments. 3. The first adjacent interference should be measured, and the co-channel D/U measured or estimated.	EO&C audio impairments in field or by digital recording. Digital error rate performance metric	From strong to weak signal areas	System performance with minimum interference Digital error rate performance metric for run
	2. Fading	1. These tests should be conducted in areas where desired stations' signal has multiple fades caused by ground conductive structures, with the interference no worse than in test B.1.1. 2. Digital program material may be the same as analog. Program material should include segments that will not mask digital impairments. 3. Tests should be repeated with station nighttime service. 4. The first adjacent interference should be measured, and the co-channel D/U measured or estimated.	EO&C audio impairments in field or by digital recording Digital error rate performance metric	From strong to weak signal areas	System performance with fading Digital error rate performance metric for run
	3. Host Compatibility	1. Compatibility tests should be conducted using two conventional AM receivers, one narrow band and one NRSC (see figure). 2. The digital signal should be switched on and off at a rate that will allow observers to rate possible analog interference. 3. Compatibility tests should be conducted using an IBOC analog station broadcasting music and talk and using moderate processing. 4. Digital recordings should be made of the analog audio for further evaluation.	Subjective	Strong and moderate signal area	Subject rating of interference using the five-step CCIR impairment scale.

IBOC FIELD TEST GUIDELINES – AM BAND REVISION #2a February 17, 1999					
Test Group	Test	TEST PROCEDURE Objectives: • System performance within entire day and night contour • System performance with fading and within the day contour Note: 1. Mobile tests to be conducted at speed limit or with traffic flow. 2. Tests should be repeated for all proposed transmission bit rates. 3. Digital recordings will be made of the digital and analog compatibility receivers' audio for all test runs.	Type of Evaluation	Signal Conditions	Test Results
C System performance within protected contour (day and night)	1. Low fading	1. These tests should be conducted in the AM station's entire day coverage area. 2. The station selected should have at least one first adjacent interferer at least 6 dB below the desired signal at points within the day contour. 3. Digital program material may be the same as analog. Program material should include segments that will not mask digital impairments. 4. Tests should be repeated with station nighttime service. 5. The first adjacent interference should be measured, and the co-channel D/U measured or estimated.	EO&C audio impairments in field or by digital recording. Digital error rate performance metric	Signal within coverage contour From strong to weak signal areas	System performance with day interference Digital error rate performance metric for run
	2. Fading	1. Test in areas with multiple fades caused by ground conductive structures with interference similar to interference in B.1. 2. Digital program material may be the same as analog. Program material should include segments that will not mask digital impairments. 3. Tests should be repeated with station nighttime service. 4. The first adjacent interference should be measured, and the co-channel D/U measured or estimated.	EO&C audio impairments in field or by digital recording Digital error rate performance metric	Signal within coverage contour From strong to weak signal areas	System performance with fading Digital error rate performance metric for run

Appendix C. Analog Receiver Selection (Field Testing)

A critical aspect of field test planning involves the selection of the analog receivers to be used. These receivers will have a profound influence on the comparison being made between the digital and analog services, as well as the results of the compatibility tests (i.e. determining the effect that IBOC DAB has on existing analog main channel audio signals).

The NRSC recommends that proponents use commercially-available analog receivers representative of a cross-section of receivers in use by consumers since, during the initial and transitional phases of IBOC DAB service introduction, these are the receivers which will primarily be in use, and therefore of primary interest with respect to analog compatibility.

In previous NRSC IBOC DAB tests, five FM and three AM radios were selected for use in compatibility testing, listed in Table C-1.[3] For FM, radios were selected from four categories: auto, portable, home Hi-Fi (high end), and home Hi-Fi (competitive). Two automobile radios were selected because of their large consumer populations and because of their dramatically different stereo-to-mono "blend" implementations. These auto radios also showed high adjacent channel rejection. The portable and personal portable use similar circuitry and have less adjacent channel rejection. The high end home Hi-Fi radios had good 2nd adjacent channel rejection, but exhibited first adjacent channel rejection characteristics similar to that found in the portable and home radios.

Table C-1. Analog Receivers Used in NRSC IBOC DAB Tests (1995)

CATEGORY	MAKE & MODEL	FM	AM
Auto	Delco model # 16192463	✓	✓
Auto	Ford model #F4XF-19B132-CB	✓	
Portable	Panasonic RX-FS430	✓	✓
Home Hi-Fi (high end)	Denon TU-380RD	✓	✓
Home Hi-Fi (competitive)	Pioneer SX-201	✓	

For mobile testing of FM IBOC systems, the NRSC strongly urges proponents to use both of the auto radios included in Table C-1. This is vital because of the characteristics just mentioned in the previous paragraph, that is, their significant performance differences combined with their widespread usage by consumers.

Additional information is provided below on the FM band performance of these auto receivers. Figure C-1 illustrates the measured separation vs. RF level. Note in particular the difference in behavior between the Ford and the Delco radios, with the Delco first achieving a 10 dB separation between the left and right channels at an RF level 27 dB below that of the Ford.

[3] See "Consumer Electronics Group, Electronic Industries Association, Digital Audio Radio Laboratory Tests - Transmission Quality Failure Characterization and Analog Compatibility, August 11, 1995" for additional information, in particular, Appendix H which contains characterization data on the receivers in Table C-1.

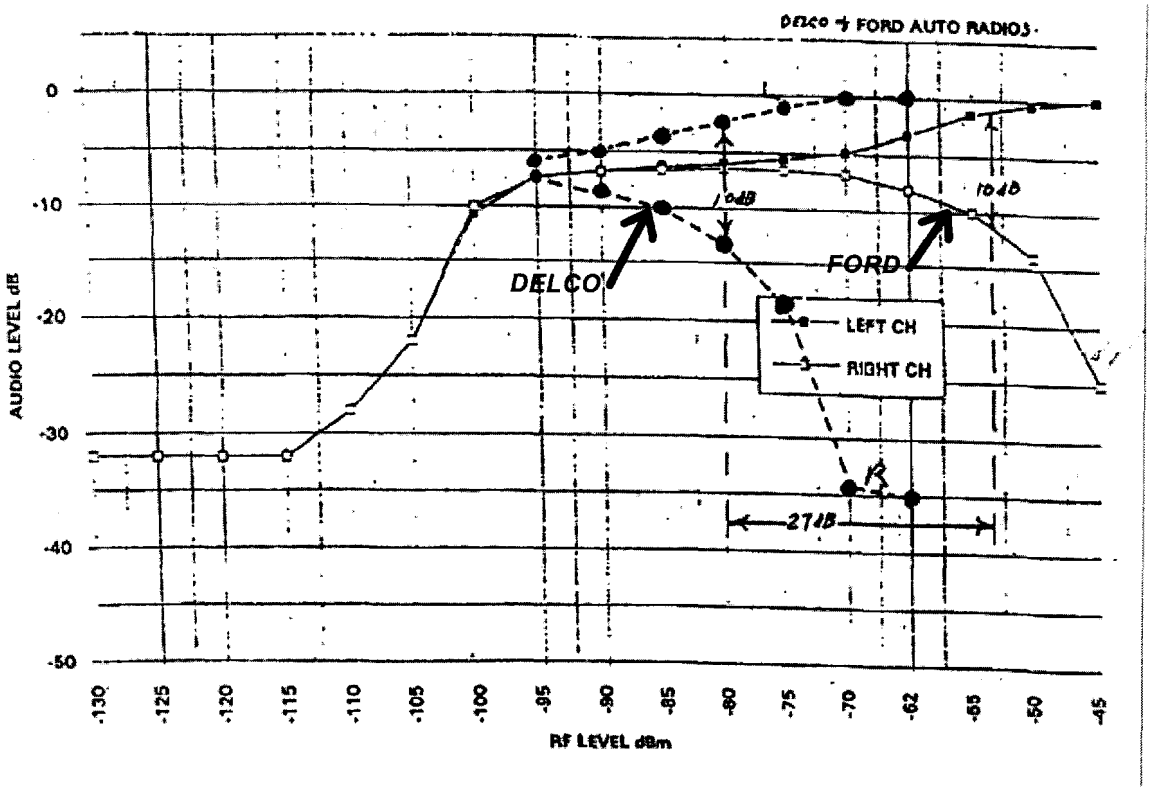


Figure C-1. Separation vs. RF Level - Delco and Ford Auto Radios (FM band)

In table C-2, the total harmonic distortion (THD) and stereo S/N performance of these two radios is shown, for moderate RF input levels.

Table C-2. FM Auto Radio Performance

Receiver	THD (at –50 dBm)	Stereo S/N RMS (at –62 dBm)
Delco	2% (at least 35 dB separation)	59 dB (35 dB separation)
Ford	1% (14 dB separation)	66 dB (5 dB separation)

Likewise, for AM IBOC tests, proponents should make use of at least two analog receivers. Figures C-2 and C-3 illustrate the frequency response of the Delco radio (AM band) by itself, and plotted along with the NRSC 75 µsec standard deemphasis curve, respectively.

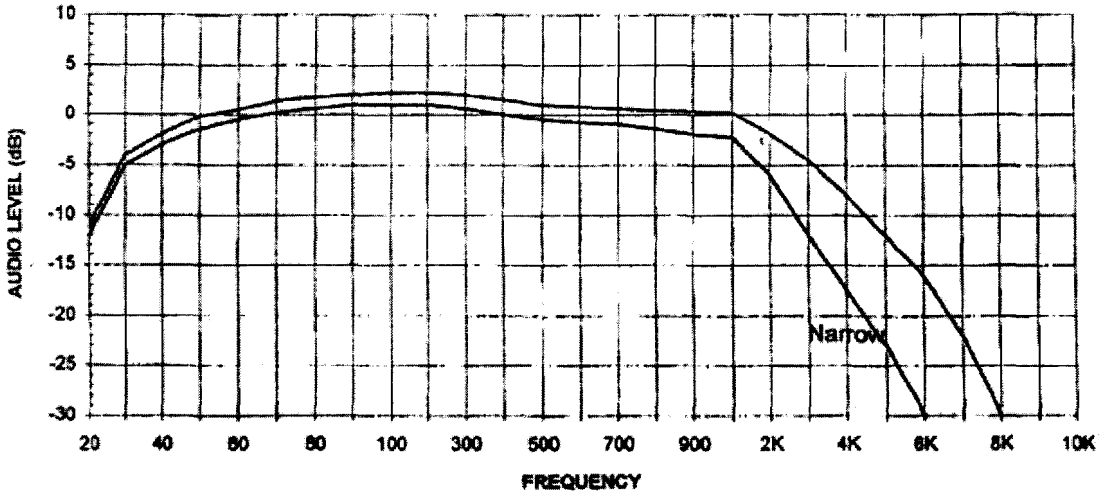


Figure C-2. AM Frequency Response - Delco Radio (narrow and wide settings)

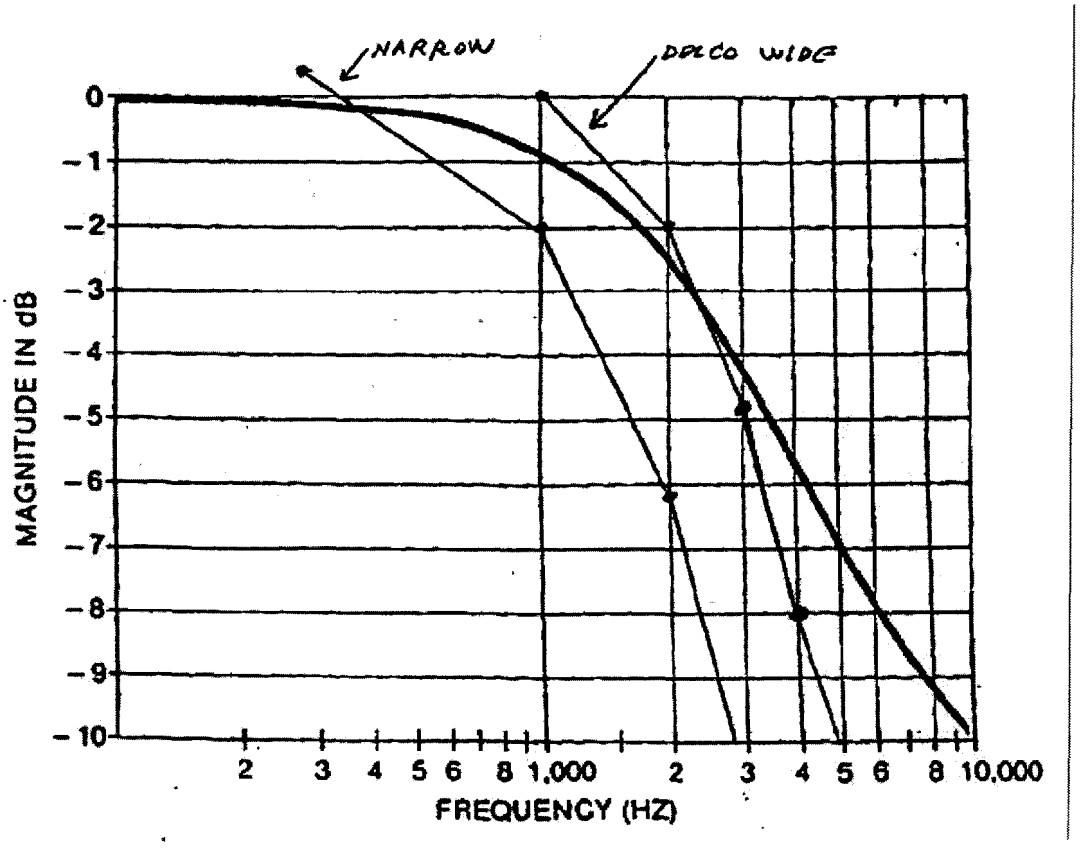


Figure C-3. Delco Radio Frequency Response Compared to 75 µsec AM Standard Deemphasis Curve

Appendix D. Test Matrix – Field Test Guidelines, FM-band Portion

FIELD TESTS, FM-BAND PORTION

TEST	DESCRIPTION				INTERFERENCE			COMMENTS
		AWGN	FIXED	MOBILE	FADING	1ST-ADJ	2ND-ADJ	
A	**System calibration**							
1)	Average and peak RF power measurements		✓					
2)	RF spectrum plot		✓					
3)	Digital audio subjective performance baseline	✓	✓					
4)	Baseline characterization of system digital performance	✓	✓					
5)	Analog transmission system test results							
6)	Transmit and receive antenna, RF distribution system performance data							
7)	Calibration record of equipment							
8)	Interference levels (calculated and measured) along test routes			✓				
B	**Strong signal with low interference**							
1)	Low multipath		✓	✓	✓			• Negligible interference from co- and adjacent-channels • Digital, analog audio impairment performance • Data transmission performance
2)	Strong multipath		✓	✓	✓			
3)	Host main channel audio compatibility		✓	✓				
4)	Host analog 67 kHz and 92 kHz subcarrier compatibility		✓	✓				
C	**Single interferer**							
1)	Single 1st-adjacent channel interferer (at FCC limit)			✓		✓		• Negligible interference from addt'l 1st and 2nd adjacent channels • Digital, analog audio impairment performance • Data transmission performance
2)	Single 1st-adjacent channel interferer (at FCC limit) with multipath			✓	✓	✓		
3)	Single 1st-adjacent channel interferer (above FCC limit)			✓		✓		
4)	Single 1st-adjacent channel interferer (above FCC limit) with multipath			✓	✓	✓		
D	**Two interferers**							
1)	Two simultaneous 1st-adjacent channel interferers (at FCC limit)			✓		✓		• Digital, analog audio impairment performance • Data transmission performance
2)	Two simultaneous 1st-adjacent channel interferers (at FCC limit) with multipath			✓	✓	✓		
3)	Two simultaneous 2nd-adjacent channel interferers			✓			✓	
4)	Two simultaneous 2nd-adjacent channel interferers (with multipath)			✓	✓		✓	

Appendix E. Test Matrix – Field Test Guidelines, AM-band Portion

FIELD TESTS, AM-BAND PORTION

TEST	DESCRIPTION				INTERFERENCE			COMMENTS
		AWGN	FIXED	MOBILE	FADING	1ST-ADJ	2ND-ADJ	
A	**System calibration**							
1)	Average and peak RF power measurements		✓					
2)	RF spectrum plot		✓					
3)	Digital audio subjective performance baseline	✓	✓					
4)	Baseline characterization of system digital performance	✓	✓					
5)	Analog transmission system test results							
6)	Transmit and receive antenna, RF distribution system performance data							
7)	Calibration record of equipment							
8)	Interference levels (calculated and measured) along test routes			✓				
B	**System performance within protected contour and low interference (day)**							
1)	Low interference (daytime)		✓	✓				• Negligible interference from co- and adjacent-channels • Digital, analog audio impairment performance • Data transmission performance
2)	Performance with fading (daytime)		✓	✓	✓			
3)	Performance with fading (nighttime)		✓	✓	✓			
4)	Host main channel audio compatibility		✓	✓				
C	**System performance within protected contour (day and night)**							
1)	Daytime performance over entire day coverage area.		✓	✓		✓		• Negligible interference from addt'l 1st and 2nd adjacent channels • Digital, analog audio impairment performance • Data transmission performance
2)	Nighttime performance over entire nighttime coverage area.		✓	✓		✓		
3)	Daytime performance over entire day coverage area with fading.		✓	✓	✓	✓		
4)	Nighttime performance over entire nighttime coverage area with fading.		✓	✓	✓	✓		

Appendix F. Suggested Field Test Assessment Data Logging Conventions and Reporting Form

Recommended FM and AM Field Test Assessment datalogging conventions are provided in Table F-1. In Figure F-1, a proposed field test data reporting form is offered. Also refer to the EIA DAR Subcommittee's field test report for additional examples of field test data reporting.

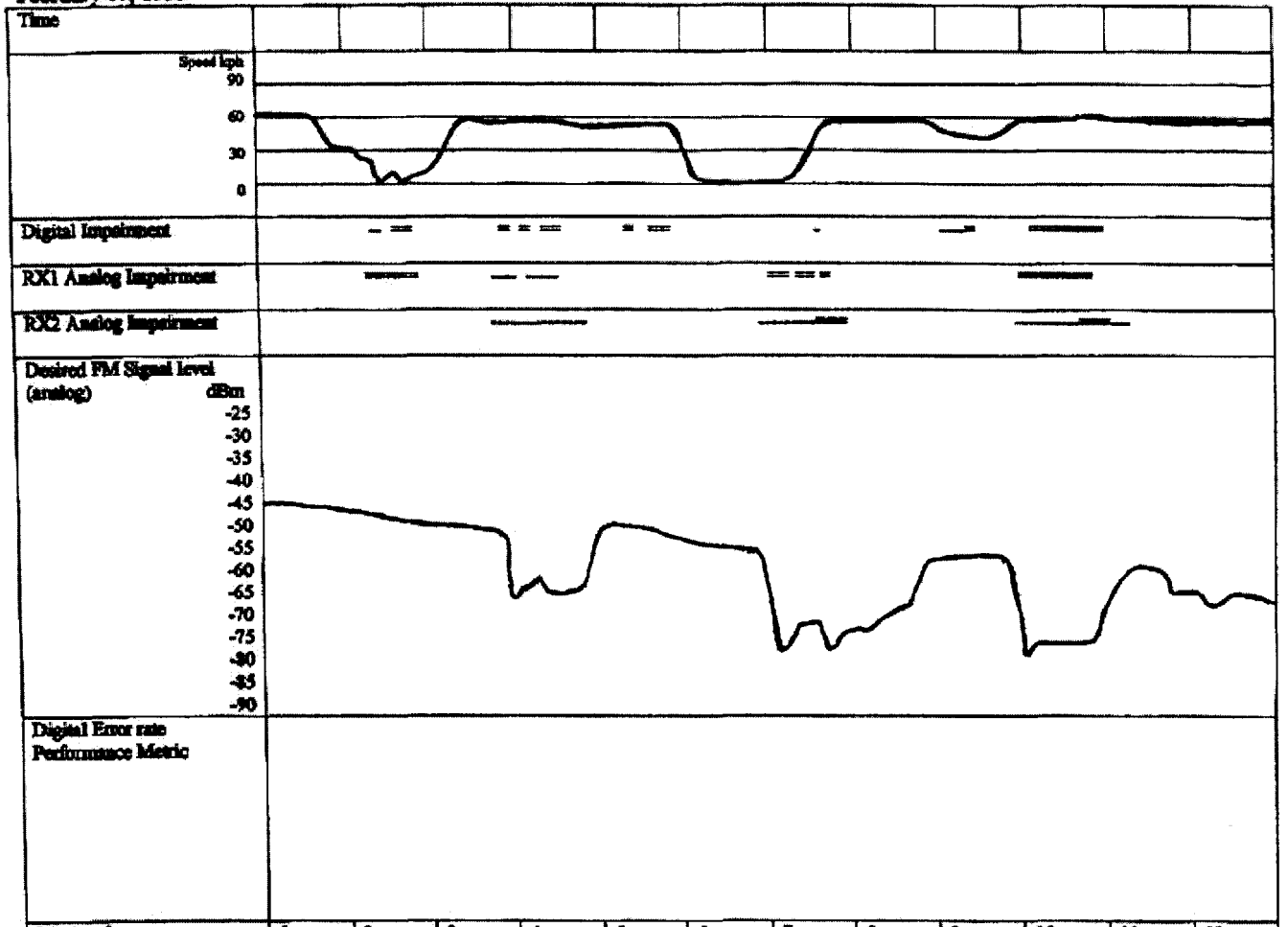
Table F-1. Suggested Field Test Assessment Datalogging Conventions

Notes:
- See also test groups A-8 in Appendices A and B.
- Recommended data to be recorded during field test runs:
  - Time
  - Vehicle speed
  - Digital audio
  - Analog audio (two receivers recommended)
  - Signal level
  - Digital error rate performance metric
  - Location and landmarks

NO	DESCRIPTION OF DATA	PERFORMANCE GRADING
1	Continuous spectrum analyzer plots (1 MHz span for FM, 50 kHz span for AM)	Digital signal interference and transmission conditions: 0 No interference 1 Single 1st adjacent 11 Upper and lower 1st adjacent 12 1st and 2nd adjacent 2 Single 2nd adjacent 22 Upper and lower 2nd adjacent 3 Low signal 4 Multipath
2	Visual recording depicting test environment	Note type of environment associated with impairments: U Urban UO Urban obstructed S Suburban UO Suburban obstructed R Rural RO Rural obstructed
3	Digital recording of IBOC audio	Grade dynamic digital impairments: 0 Imperceptible 1 Perceptible (-) 2 Failure (=)
4	In-motion digital recording of analog receiver audio	Grade dynamic analog impairments: 0 Imperceptible 1 Perceptible (-) 2 Very annoying/no signal (=)

DRAFT
February 17, 1999

Field Test Reporting Form



Landmark	1	2	3	4	5	6	7	8	9	10	11	12
Location Environment	U	U	U	UO	U	U	SO	S	S	RO	R	R
Interference Scenario	1	0	0	0	12	1	0	0	11	1	0	0

Figure F-1. Suggested Field Test Data Reporting Form

Appendix G. DAB Subcommittee Goals & Objectives

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5/14/98

DAB Subcommittee

Goals & Objectives

(as adopted by the Subcommittee on May 14, 1998)

Objectives

(a) To study IBOC DAB systems and determine if they provide broadcasters and users with:

- A digital signal with significantly greater quality and durability than available from the AM and FM analog systems that presently exist in the United States;
- A digital service area that is at least equivalent to the host station's analog service area while simultaneously providing suitable protection in co-channel and adjacent channel situations;
- A smooth transition from analog to digital services.

(b) To provide broadcasters and receiver manufacturers with the information they need to make an informed decision on the future of digital audio broadcasting in the United States, and if appropriate to foster its implementation.

Goals

To meet its objectives, the Subcommittee will work towards achieving the following goals:

(a) To develop a technical record and, where applicable, draw conclusions that will be useful to the NRSC in the evaluation of IBOC systems;

(b) To provide a direct comparison between IBOC DAB and existing analog broadcasting systems, and between an IBOC signal and its host analog signal, over a wide variation of terrain and under adverse propagation conditions that could be expected to be found throughout the United States;

(c) To fully assess the impact of the IBOC DAB signal upon the existing analog broadcast signals with which they must co-exist;

(d) To develop a testing process and measurement criteria that will produce conclusive, believable and acceptable results, and be of a streamlined nature so as not to impede rapid development of this new technology;

(e) To work closely with IBOC system proponents in the development of their laboratory and field test plans, which will be used to provide the basis for the comparisons mentioned in Goals (a) and (b);

(f) To indirectly participate in the test process, by assisting in selection of (one or more) independent testing agencies, or by closely observing proponent-conducted tests, to insure that the testing as defined under Goal (e) is executed in a thorough, fair and impartial manner.

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(adopted 4/17/99)

DAB SUBCOMMITTEE
IBOC DAB System Test Guidelines (Part II – Field Tests)

Addendum #1
Out-of-channel Power Measurement Procedure

This addendum describes a recommended procedure for characterizing the out-of-channel signal power at the output of an FM transmitter due to the addition of an IBOC digital signal to a normal analog FM transmission.

The procedure described herein augments information contained in Section 5.1.1 (Test A – System Calibration) of the field test guideline, specifically, Desired Result #5 (Analog transmission system test results). Proponents intending to submit IBOC system performance data to the NRSC for evaluation are asked to include the data being requested by this addendum in addition to desired results already spelled out in the test guidelines documents.

Assumed in this procedure is that the FM IBOC signal consists of upper and lower (with respect to the analog host) digital sidebands (refer to Figure 1, and also to Appendix G of Part I of the IBOC DAB System Test Guidelines for additional information). For the purposes of this procedure, "out-of-channel" refers to that portion of the RF spectrum immediately adjacent to the outer edges of the upper and lower digital sidebands, as shown in Figure 1. Note that the out-of-channel region, as defined, may vary from system to system, and that the out-of-channel region also may include frequencies which fall within the FCC mask for the system under test.

The suggested procedure is divided into two parts. The first part is designed to characterize the out-of-channel energy immediately adjacent to the digital sidebands, which would fall within a 2nd adjacent signal's digital sidebands were a 2nd adjacent signal present.

In the second part, the out-of-channel energy due to third-order intermodulation products, falling in the spectral region from 200 kHz to 600 kHz above and below the signal under test center frequency, is measured. Note that this region represents the spectral extent of a 2nd adjacent channel IBOC signal.

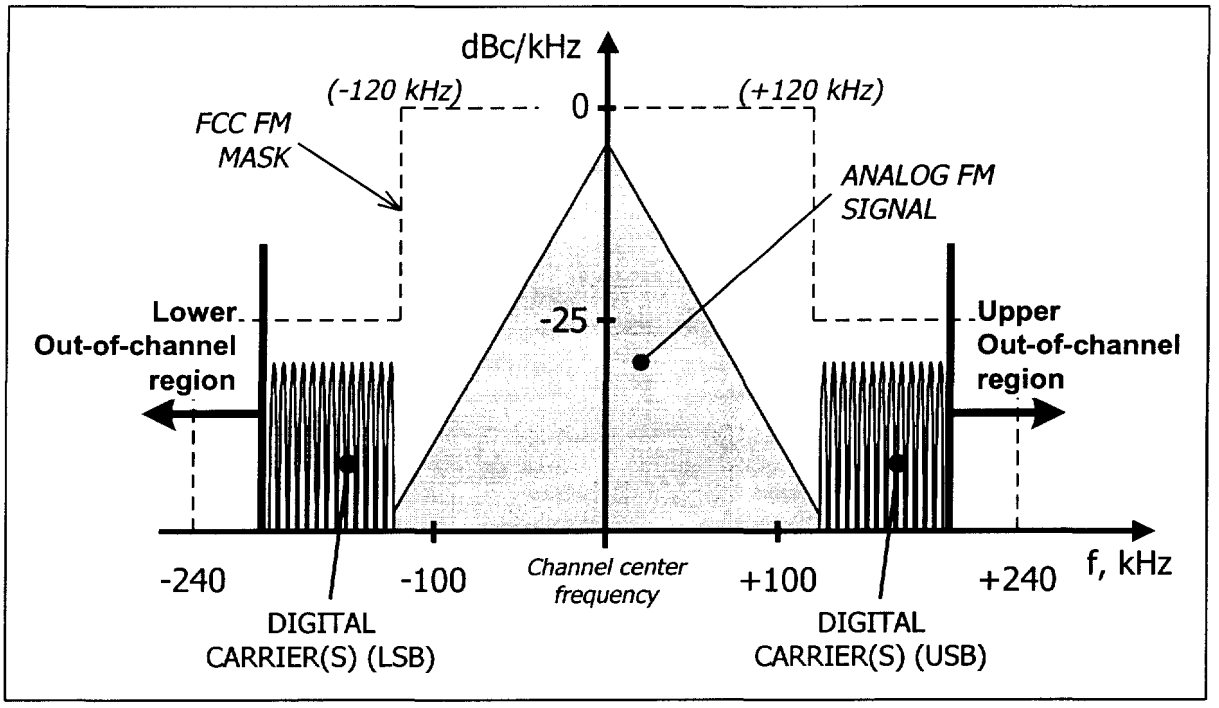

Figure 1. Illustration of "out-of-channel" region for an FM IBOC system, as defined for the purpose of this addendum.

(DRAFT #2)
OUT-OF-CHANNEL POWER MEASUREMENT PROCEDURE
March 22, 1999

Objectives:

1. Measure IBOC digital signal power in IBOC adjacent channels.

2. Measure third order products between 390 kHz to 600 kHz above and below host FM center frequency.

Digital power in IBOC adjacent channel

1. Measurements should be made at the output of the combiner (antenna input port) into a dummy load with the transmitter operating in its normal IBOC mode. Test will be repeated into the transmitting antenna.

2. First part of test will be conducted with analog transmitter off.

3. Measure total digital power with an average power meter (both digital sidebands on).

4. Measure individual 70 kHz sideband average power with a spectrum analyzer using the adjacent-channel power feature (see HP8591E series). The individual sideband should be 3 dB below thpower meter total average power reading.

5. To measure the power in the adjacent IBOC channel, set thespectrum analyzer adjacent-channel power frequency marker at the frequency where the second adjacent channel starts (same sideband width). Power is measured in dB below the host IBOC individual sideband.

6. Repeat measurements with analog transmitter on.

Third order products

1. Measurements should be made at the output of the combiner (antenna input port) into a dummy load with the transmitter operating in its normal IBOC mode. Test will be repeated into the transmitting antenna.

2. First part of test will be conducted with analog transmitter off.

3. Measure out-of-channel power from 200 - 600 kHz above and below the host FM center frequency by averaging the power spectral density of the signal in each 1 kHz bandwidth over a 15-second segment of time.

4. Repeat measurements with analog transmitter on and digital transmitter off.

5. Final step is to repeat the measurements with analog and digital transmitters on.

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(adopted 4/17/99)

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IBOC DAB System Test Guidelines (Part II – Field Tests)

Addendum #2
Qualitative Characteristics of Field Test Routes

This addendum provides additional information regarding desirable qualitative aspects (from a system testing standpoint) of mobile routes used for field testing IBOC systems. Proponents intending to submit IBOC system performance data to the NRSC for evaluation are asked to consider the information in this addendum as they plan their test routes for data collection.

As discussed in the Field Test Guidelines, the NRSC expects proponents to collect a significant part, if not the majority, of the field test data from a mobile platform, given that the mobile environment offers some of the most severe and demanding conditions encountered, and because this is the environment where a large percentage of radio listening occurs. Some of the key qualitative characteristics the selected field test routes should have are as follows:

- Line-of-sight condition (to antenna)
- Terrain shielded condition
- Significant shielding by buildings
- Vertical shielding (tunnels/wires)
- Major over-water propagation path
- Travel along waterfront areas
- Significant foliage along part of propagation path
- Rural areas
- Primarily highway travel
- Residential areas covered/directly adjacent
- "Fringe"FM reception areas

It is recommended that proponents select test routes such that at the conclusion of their test program, all of these characteristics are evident in the collected data.

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Addendum #3
Additional Information on Data Formatting

This addendum provides additional information regarding data formatting of IBOC system data submission. Proponents intending to submit IBOC system performance data to the NRSC for evaluation are asked to consider the information in this addendum as they prepare their submission.

Recorded audio – the NRSC expects that proponents will use a variety of recording media for data collection including but not limited to digital audio tape (DAT) and digital recording directly onto hard disks and/or compact discs (CDs).

The preferred format for audio recording submission to the NRSC is linear CD audio with a sampling rate of 44.1 kHz. Use of the CD format minimizes or eliminates the possibility of alteration of the submitted material and allows the evaluators to make use of widely available, high-quality playback equipment. Alternatively, a proponent may elect to submit audio in DAT format.

The use of digital audio compression (for the purpose of bit rate reduction) at any point in the audio collection process would be inadvisable, and the NRSC assumes that the only digital audio compression existing in any submitted recordings is that of the IBOC perceptual audio coding system alone.

Computer-based data – in the event that a proponent submits data in computer form, it should be in "machine-readable"format, using tabs, commas, or quotation marks to delimit the different fields of data. Spaces may also be used as a delimiter in combination with the delimiters identified above or, when on ambiguity would result, alone. Data may also be presented in any format that can be imported into a Microsoft Excel spreadsheet.

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Addendum #4
Inclusion of "Mode" signal in data report

This addendum provides additional information regarding specific data being requested for inclusion in an IBOC system data submission. Proponents intending to submit IBOC system performance data to the NRSC for evaluation are asked to consider the information in this addendum as they prepare their submission.

At the August 13, 1999 meeting of the Evaluation Working Group, a need was identified for a "mode" signal to be included as part of a proponents submission of test results. This group has determined that such information will be instrumental in characterizing the operation of IBOC systems which utilize different modes based on transmission conditions.

This mode signal would indicate the particular mode of an IBOC audio signal versus time (for example, as part of a field test run) or versus operating point (as in a laboratory adjacent channel test), and would be analogous to the stereo pilot indicator provided by an analog FM stereo receiver. This information would apply to all tests, i.e., the IBOC audio signal mode is of interest for all modes of operation and under any test conditions.

Based on the technical disclosures made by the current IBOC proponents, it is expected that for USA Digital Radio, the mode indicator would indicate when the IBOC audio had "blended to analog," and for Lucent Digital Radio, the number of streams actually being used in the multi-stream audio processing at the receiver (*e.g.*, from 1 to 4 for their FM system). For Digital Radio Express, it is not presently known if a mode signal would be appropriate, however, DRE is requested to make this evaluation based on the needs of the NRSC as expressed herein and on the particulars of their system's design.

Proponents are also encouraged to submit any auxiliary information which would help to characterize the audio quality represented by a particular mode (as indicated by the mode signal), for example, by conducting subjective evaluations on data for which the mode signal information has been collected.